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I. Gupta has continued his research on tungsten-carbon alloys. One of his objectives has been to identify beyond doubt the source of the streaks he finds in carburized tungsten. This objective has not yet been accomplished. However, several potential causes have been eliminated. The streaks are not due to the formation of precipitates on cooling. They are not associated with the locking of dislocations present in the crystal prior to carburization. The streaks must, by the nature of the imaging process, arise either from a step offset at the tip surface which acts to concentrate the field or from some heterogeneity lying along planes of the streaks that change the potential above tungsten atoms.

New information concerning the streaks observed in tungsten-carbon alloys follows: (1) Associated with the streaked patterns is a new pole figure, which is approximately $\langle 112 \rangle$ parallel to the wire axis in place of the $\langle 110 \rangle$ which is the predominant texture found in the as-drawn and recovered tungsten wire. (2) Streaks have been found in wires carburized either by heating in a methane + helium atmosphere or by heating a wire coated with WC at temperatures as low as 1250°C .

These new observations suggest that secondary recrystallization occurs during carburization at temperatures at least as low as 1250°C. This suggestion is being checked with the help of x-ray diffraction observations of the carburized wires. It is supported by the observation of a $\langle 111 \rangle$ minor pole figure component in field ion microscope patterns of pure W.

If this suggestion is valid, then it appears that carbon acts to diffuse along the grain boundaries, to prevent the motion of certain of these boundaries but not of certain special boundaries. In this way, the requirements for the onset of secondary recrystallization are satisfied. According to this model, the streaks are then either stacking faults or thin W_2C precipitates either of which act as sinks for the carbon atoms which were in the grain boundaries prior to their elimination during the secondary recrystallization process. Experiments are underway to check this hypothesis using thin film electron transmission microscopy.

Another series of observations have been made about the field evaporation behavior of C in W. In the course of field evaporation of a carbon containing W tip, it has been found that the number of extra

bright spots centered about the $\langle 100 \rangle$ pole on the surface increases, whereas the number about the $\langle 110 \rangle$ pole remains constant in a sequence of alternating field evaporation and imaging. The number of $\langle 100 \rangle$ extra spots per total number of W atoms removed is approximately equal to the number of extra $\langle 110 \rangle$ centered spots (excluding the spots along the zone axis) per number of surface W atoms.

These observations suggest that the extra bright spots are interstitial C atoms, which cannot be field evaporated from the (100) region but can from the (110) region. Further, these observations suggest a method for measuring the lattice solubility of carbon and other interstitials in refractory metals. In this respect, it must be noted that interstitial elements in W are mobile at 78°K in the highly stressed tip region.

Extra bright spots have been seen to appear during imaging. (It is believed possible to distinguish between the interstitial species observed in this manner because the order of their disappearance from the (110) region with voltage increasing above the imaging voltage is oxygen, nitrogen and carbon.) Because of this mobility, the suggested technique would require the tip to be maintained at 20°K.

A liquid hydrogen Joule-Thomson generator has been purchased to enable the microscopes to be used down to 20°K with safety. It is planned to study the lattice solubility of interstitial elements in tungsten using the above suggested technique.

M. Attardo has completed his M.S. thesis on a "Study of Radiation Damage in Platinum." This work was supported by the subject grant and an abstract of the thesis is attached to this report as Appendix A. A technical report based on his thesis is being prepared.

E. Gold has succeeded in imaging tantalum. He has prepared various tantalum-carbon alloys for comparison with the work of I. Gupta on tungsten-carbon alloys.

Considerable effort has been invested in the replacement of glass microscopes with stainless steel units because most of the down time we have had in the past has been associated with the breakage and repair of glass units by inept glass-blowing facilities available to us.

Appendix A

A Field Ion Microscope Study of Radiation Damage in Platinum
by M.J. Attardo

The effects of room temperature neutron irradiation on Pt have been studied using a helium field-ion microscope. It has been conclusively shown that individual interstitials introduced by the neutron irradiation are present at room temperature. This is significant because stage I and stage II recovery in Pt takes place below room temperature, whereas stage III recovery in Pt occurs above room temperature. We believe this observation to be the first conclusive direct evidence that interstitials are in fact the defect associated with stage III recovery.

Observations also revealed clusters of defects present at room temperature. It was found that interstitials cluster in a preferred geometrical shape, namely, tetrahedra. No regular habit form was found for all vacancy clusters observed. No observation of single or divacancies has been made.

It was also found that regions of large amounts of damage alternate with regions of near perfection. The approximate size of these damaged regions is of the order of 100 atomic layers.